J Raptor Res. 35(4):399–407

CONSERVATION OF THE BURROWING OWL IN WESTERN NORTH AMERICA: ISSUES, CHALLENGES, AND RECOMMENDATIONS

GEOFFREY L. HOLROYD[1]
Canadian Wildlife Service, Room 200, 4999–98 Ave., Edmonton, AB T6B 2X3 Canada

RICARDO RODRÍGUEZ-ESTRELLA
Centro de Investigaciones Biológicas del Noroeste, Mar Bermejo 195, Col. Playa Palo Santa Rita, Apdo. Postal 128, La Paz 23090 B.C.S. México

STEVEN R. SHEFFIELD
U.S. Fish and Wildlife Service, 4401 N. Fairfax Dr., Suite 634, Arlington, VA 22203 U.S.A. and Department of Biology, George Mason University, Fairfax, VA 22030 U.S.A.

ABSTRACT.—Burrowing Owls (*Athene cunicularia*) are undergoing mild to relatively severe local and regional population declines throughout much of western North America. In Canada, Burrowing Owls are declining precipitously and are listed as endangered. In the United States of America, Burrowing Owls continue to decline in many states, but they are not listed federally. In Mexico, there is little quantitative data, but the species is listed as threatened. Here, we propose a conservation plan with five major action components: status, management and conservation, education, research, and administration. Given continued declines of Burrowing Owls in many parts of western North America, we urge increased cooperation among interested agencies and organizations to implement effective conservation of this species.

KEY WORDS: *Burrowing Owl*; Athene cunicularia; *conservation*; *population decline*; *status*; *sciurid*; *international cooperation*; *Canada*; *Mexico*; *United States of America*; *North America*.

Conservación del Búho Cavador en el occidente de Norte America: tareas, retos, y recomendaciones

RESUMEN.—Los Búhos Cavadores (*Athene cunicularia*) han experimentado a nivel local y regional un declive moderado a relativamente severo de sus poblaciones en la mayoría del oeste de Norte América. En Canadá, los Búhos Cavadores están declinando precipitadamente y son considerados como una especie en peligro. En los Estados Unidos de América, los Búhos Cavadores continúan declinando en muchos estados, pero no están en ningún listado a nivel federal. En México, hay muy pocos datos cuantitativos, pero aun asi la especie es listada como bajo amenaza. En este articulo, nosotros proponemos un plan de conservación con cinco grandes componentes: estado, manejo y conservación, educación, investigación y administración. Dado el continuo declive de los Búhos Cavadores en muchas partes del oeste de Norte América, nosotros hacemos un llamado urgente para incrementar la cooperación entre las agencias interesadas y las organizaciones para implementar una conservación efectiva de esta especie.

[Traducción de Victor Vanegas y César Márquez]

During the second international Burrowing Owl symposium (29–30 September 1998 in Ogden, Utah), participants presented papers on the status of the western Burrowing Owl (*Athene cunicularia hypugaea)* in many states and provinces of the United States (U.S.), Mexico, and Canada. Papers were also presented on aspects of the owl's biology, management, and conservation. The objectives of this paper are to summarize conservation issues that affect the western Burrowing Owl and its habitats, and to recommend possible solutions. These recommendations include international coordination and cooperation, standardized monitoring, education, policy change, management and conservation, and research.

[1] E-mail address: Geoffrey.Holroyd@ec.gc.ca

This paper integrates ideas from several papers included in the symposium and synthesizes open discussion from the final session of the symposium. These papers, and the discussion, focused on the status and conservation needs of the Burrowing Owl in the three countries of North America. At the final session, symposium attendees agreed that the western Burrowing Owl is declining over most of its range in North America. They based this conclusion on information provided in 34 oral presentations included in the symposium. Articles based on many of these presentations, plus a few others, are included in this volume of the *Journal of Raptor Research.*

Attendees at the symposium's final session contributed to this proposed conservation plan, which was further reviewed and refined in early 2001. The intended audience for this plan is all wildlife managers in western North America, but particularly the wildlife and land management agencies in Mexico, U.S., and Canada, within the range of the western Burrowing Owl (Wellicome and Holroyd 2001). The goals of this conservation plan are: 1) to encourage land-use practices that reverse the population decline of the western Burrowing Owl; 2) to determine what factors, not related to habitat modification, may also contribute to the species' decline; and 3) to help conserve the ecological integrity of grasslands in western North America. These goals can be achieved through conservation action and improved cooperation among wildlife agencies, land managers, and the public in these three countries.

The western Burrowing Owl inhabits grassland ecosystems of midwestern and western North America. These ecosystems have been greatly modified by human perturbations (Samson and Knopf 1996). Overall, <25% of the original grasslands remains as native vegetation in Canada and the U.S., but in some states and provinces as little as 1% remains (World Wildlife Fund Canada 1988, Samson and Knopf 1996). In Mexico, 12% of the land area was dominated by grasslands that were mainly distributed in the northern part of the country (Sonora, Chihuahua, Durango, Coahuila, Nuevo Leon, Zacatecas, Aguascalientes, and Jalisco; Rzedowski 1978). Grassland patches in Mexico originally were distributed widely throughout several ecosystem types, though most grassland has since disappeared because of human activities. Grasslands in Mexico are used intensively by the livestock industry (Miller et al. 1994).

In the U.S., Burrowing Owls have experienced both local and regional population declines (Sheffield 1997a). In 1972, the Burrowing Owl was included on the Audubon Blue List, a list intended to provide an early warning about North American bird species undergoing population or range reductions (Tate 1986). In the U.S., the Burrowing Owl has been designated as vulnerable (U.S. Department of Interior 1991), sensitive (U.S. Department of Interior 1992), federal category 2 candidate species per listing under the Endangered Species Act, and declining (White 1994). The federal category 2 candidate species classification was officially dropped by the U.S. Fish and Wildlife Service (USFWS) in late 1996 (published in the 5 December 1996 Federal Register). Currently, the Burrowing Owl has no federal regulatory designation in the U.S., but is included as a national priority species by the USFWS in their most recent Birds of Conservation Concern 2001 list (U.S. Fish and Wildlife Service 2001). The owl is listed as a national conservation priority species, and also listed as a regional conservation priority species in USFWS Regions 1, 2, and 6, which includes midwestern and western U.S. A status assessment of the western Burrowing Owl in the United States is being prepared currently (S. Jones and L. Ayers pers. comm.).

In Canada, the Committee on the Status of Endangered Species in Canada (COSEWIC) classified this species as threatened in 1979 (Wedgwood 1978), confirmed it as threatened in 1991 (Haug and Didiuk 1991), and changed its designation to endangered in 1995 (Wellicome and Haug 1995). Burrowing Owls were extirpated from British Columbia in the 1970s (Wedgwood 1978) and from Manitoba in 1998 (K. De Smet pers. comm.). Range contraction and population declines have been particularly acute in Canada (Wellicome and Holroyd 2001). Numbers declined by an average of 20% per yr in Alberta (1991–2000, Operation Burrowing Owl [OBO] Alberta publ. comm.), 21.5% per yr in Saskatchewan (1988–2000, OBO Saskatchewan, Skeel et al. 2001), and 25% per yr in Manitoba (1987–98, De Smet 1997). A national recovery team has met annually since 1989, and a Canadian recovery plan was published in 1995 (Hjertaas et al. 1995).

In Mexico, the Burrowing Owl was listed as a federally threatened (amenazada) species in 1994 (Diario Oficial de la Federación 1994). The Burrowing Owl is widely distributed in Mexico (Welli-

come and Holroyd 2001), especially in northern arid regions, and is common at a few locations (Haug et al. 1993, Enriquez-Rocha 1997, R. Rodriguez-Estrella and G. Holroyd unpubl. data). Enriquez-Rocha et al. (1993) and Enriquez-Rocha (1997) analyzed 279 records of Burrowing Owl specimens from 27 museums (6 Mexican, 21 foreign) and found that Burrowing Owls were distributed widely, and located in 28 of 32 Mexican states. There is virtually no published information on population estimates or trends of resident or migrant Burrowing Owls in Mexico (R. Rodriguez-Estrella pers. comm.). Most reports in Mexico are anecdotal, mainly distributional records, with only a few referring to its ecology (Clark et al. 1997). Since the 1992 International Burrowing Owl Symposium (Lincer and Steenhof 1997), only four papers have been published on this owl in Mexico, two of which were published in the proceedings of that meeting (Enriquez-Rocha 1997, Rodríguez-Estrella 1997); of the other two, one was a general review of owls in Mexico (Enriquez-Rocha et al. 1993) and the other was specific to owls in Baja California (Palacios et al. 2000). Without information on the number and trends of owls, there is no way to determine quantitatively the current status of resident and wintering populations of the Burrowing Owl in Mexico.

In North America, the Burrowing Owl is protected by national and state/provincial laws. In the U.S. and Mexico it is protected under national laws that enact the Migratory Bird Treaty of 1972. The Burrowing Owl has some form of special status in 12 states (James and Espie 1997). The Canadian–U.S. Migratory Bird Convention (1916) does not include Burrowing Owls or other raptors. Therefore, in Canada, it is protected under provincial wildlife acts in the four western provinces where the species occurred historically. In addition, Burrowing Owl is listed by The Convention on International Trade in Endangered Species (CITES) in Appendix 2, which makes it illegal to possess or trade this species (including any body parts). The Burrowing Owl is classified as a neotropical migrant by Partners in Flight.

Several issues and threats are responsible for the current plight of the Burrowing Owl in North America (Haug et al. 1993, Lincer and Steenhof 1997). Burrowing Owls are faced with an ever-changing landscape, and less and less suitable habitat. Ecologically, they are often associated with fossorial (digging) species of mammals (e.g., prairie dogs [*Cynomys* spp.], ground squirrels [*Spermophilus* spp.], and badger [*Taxidea taxus*]), which are all commonly eradicated by humans. Prairie dog populations continue to decline because of sylvatic plague and eradication programs (Bishop and Culbertson 1976, American Society of Mammalogists 1998). Ground squirrels also are eradicated in many grassland regions. Pesticides used extensively on grasslands inhabited by Burrowing Owls cause both direct and indirect mortality (Sheffield 1997b). Burrowing Owls continue to lose suitable habitat and are killed by human activities, and they often fledge far fewer young than their reproductive potential would allow (Wellicome 2000). The challenge that we face is how to best manage all of the problems facing the Burrowing Owl, so we can ensure that grasslands of the future will include this unique species.

After the First International Burrowing Owl Symposium, Lincer (1997) summarized 11 issues and needs identified as important to the conservation and management of the Burrowing Owl. All of these issues, and others, were discussed at the Second Symposium and incorporated into this paper. In this paper, we have organized conservation issues that affect the Burrowing Owl into five categories: status, management and conservation, education, research, and administration. In some cases, we have been able to provide an update on actions undertaken to mid-2001.

POPULATION STATUS AND DISTRIBUTION

The status of the western Burrowing Owl in North America has not been assessed adequately, and no standardized survey data exist for this species across its range. In Canada, Burrowing Owls have been extirpated in British Columbia (Wedgwood 1978) and Manitoba (K. De Smet pers. comm.). They still breed in southern Alberta and Saskatchewan, but their range has contracted from the north and east (Wellicome and Holroyd 2001). In the U.S., Burrowing Owls occurred from western Minnesota and Iowa south to northern Texas and west from California to Washington. However, their range has been reduced, particularly in the east (Haug et al. 1993, Wellicome and Holroyd 2001). They no longer occur in Minnesota, Iowa, the eastern parts of the Dakotas, south to central Oklahoma (Haug et al. 1993, Wellicome and Holroyd 2001, Sauer et al. 2000, Sheffield and Howry 2001). According to Breeding Bird Surveys (BBS), the number of Burrowing Owls have declined in

the Great Plains at over 1.5% per yr from 1966 to 1996 (Sauer et al. 2000). In Mexico, Burrowing Owls breed from Aguascalientes north between the Sierra Madre Oriental and Occidental, and in Baja California and parts of Sonora, but little is known about their breeding population status or their range and status in winter (Enriquez-Rocha et al. 1993, Enriquez-Rocha 1997).

During the symposium, historical and current data on Burrowing Owl abundance and distribution were presented. However, much of the information was qualitative and none of it was standardized among jurisdictions. The North American BBS shows a non-significant decline (3.8% per yr) in the central BBS region and a significant decline of 12% per yr in Canada but detection rates are low (0.63 and 0.05 owls per route, respectively, Sauer et al. 2000). In the western BBS region the number of owls increased by 4.8% per yr (P = 0.03) although again the number of detections are low (0.44 owls per route).

Status Action Items

(1) Determine the status of the Burrowing Owl in the U.S. using existing information. A status assessment of the western Burrowing Owl in the United States is being prepared (S. Jones and L. Ayers pers. comm.).
(2) Undertake a standardized survey for western Burrowing Owls in North America to establish a quantitative baseline for future assessments of overall population trends. For example, recent surveys of prairie dogs have identified 1000s of colonies in the Great Plains from the Dakotas to Texas. Burrowing Owls should be surveyed and regularly monitored on these colonies.
(3) Test survey protocols for nesting Burrowing Owls in a variety of habitats so that the continental survey follows prescribed quantitative techniques.
(4) Compile historical information on Burrowing Owls, prairie dogs, and other fossorial mammals in western North America.

MANAGEMENT ACTIVITIES

Grassland habitats are managed directly and indirectly on private and public lands, but the needs of Burrowing Owls are seldom considered. On public lands, managers should consider the needs of Burrowing Owls in their land-use planning and operations. Environmental assessment of developments, pesticide applications, grazing regimes, and other human activities should be evaluated to determine their effect on Burrowing Owls.

Information is lacking on the effects of human activity and human-dominated environments on the biology and habitat use of Burrowing Owls. Some Burrowing Owls may take advantage of areas containing crop fields and orchards, particularly migrant species in their wintering areas, to exploit abundant food sources (i.e., insects and rodents; Rodríguez-Estrella et al. 1998). However, intensive cultivation of grasslands and native prairies is a suggested cause of declines in populations of breeding owls (Haug et al. 1993).

Ideally, conservation programs for Burrowing Owls include landowner stewardship on both private and public lands. In Saskatchewan and Alberta, >750 landowners voluntarily protect 100 000 ha of prime nesting habitat through stewardship programs called Operation Burrowing Owl (Skeel et al. 2001). Rocky Mountain Bird Observatory also has launched the Prairie Partners program for stewardship of grassland habitat to conserve the Burrowing Owl and other grassland species in Colorado, Wyoming, Montana, and New Mexico (Vercauteren et al. 2001). Because Burrowing Owls nest in burrows of prairie dogs, ground squirrels, and other fossorial mammals, the owls' future is tied to the conservation of these mammals and their native habitats.

To date, translocations of Burrowing Owls have met with some success (Delevoryas 1997, Feeney 1997, Schultz 1997), but re-establishment of populations has been unsuccessful in Manitoba (De Smet 1997), B.C. (Leupin and Low 2001), Minnesota (Martell et al. 2001), and Saskatchewan (L. Todd unpubl. data).

Management Action Items

(1) Determine habitats used by Burrowing Owls, map the distribution of these habitats throughout western North America, and determine threats to these habitats.
(2) Develop and standardize mitigation protocols for developments and disturbances, such as airports and oil and gas developments, to minimize impacts on Burrowing Owls. Standardized assessment guidelines for the petroleum industries' impacts on Burrowing Owls and other prairie species of special concern in Canada were recommended by Scobie and

Faminow (2000) and could be used as a template for further work.

(3) Include Burrowing Owl issues in land management plans for public lands, Environmental Impact Statements for National Grasslands (U.S.), and Management Plans for National Parks and Prairie Farm Rehabilitation Agency lands (Canada). The Burrowing Owl should be included in Habitat Conservation Plans and in the Candidate Conservation Agreement with Assurances program for black-tailed prairie dogs in the U.S.

(4) Review Burrowing Owl reintroduction techniques, and develop new techniques because reintroduction programs in four jurisdictions have not been successful.

(5) Manage rangelands to enhance productivity and survival of the owls, their prey, and fossorial mammals.

(6) Summarize design and installation techniques for artificial nest burrows for the Burrowing Owl and review their efficacy. In 1999, Saskatchewan Environment and Resource Management printed a booklet on this topic (Poulin 1999). The conservation value of artificial burrows also should be determined.

(7) Conduct follow-up research to determine the breeding success of translocated Burrowing Owls and, ultimately, to develop effective translocation techniques.

(8) Identify and conserve wintering habitats for Burrowing Owls. Owls are known to winter in south Texas, Gulf coast lowlands and central Mexico, southern California, Baja, and local areas in northern Mexico and adjacent U.S., but little is known about habitat use during winter.

(9) Ensure pesticides have no negative effects on Burrowing Owls on both breeding and wintering grounds.

(10) In the U.S. and Mexico, implement voluntary land-stewardship and management programs like Operation Burrowing Owl and Prairie Partners.

(11) Promote stewardship of Burrowing Owls and their habitat on all government lands within the owls' range in all three countries. A coordinated effort is needed by federal agencies to promote and to manage biodiversity in native grasslands.

(12) Review government programs and policies to ensure that land-use changes have a positive effect on the conservation of Burrowing Owls, their habitats, and associated wildlife, such as fossorial mammals.

(13) Conserve prairie dogs, ground squirrels, and badgers to provide nesting burrows and habitat for owls. Prairie dog colonies should be expanded substantially on public lands. Land-use practices and legislation should make it profitable and beneficial to maintain and to conserve prairie dog populations on private lands. Federal, state, and locally-supported control programs should be re-evaluated to ensure that adequate populations of prairie dogs and ground squirrels remain to support all species associated with this ecosystem.

EDUCATION

Burrowing Owl conservation depends on the attitudes of grassland landowners, land managers, and society in general. A change of philosophy with regard to prairie dogs, ground squirrels, and grasslands is required. Some sectors of society view grasslands as non-productive, easily-developed, weedy, or problem areas; whereas, they should be conserved as an integral part of natural, functioning ecosystems, and as the basis for a sustainable economy. We will have to work hard to change the negative image of prairie dogs and ground squirrels. Educational materials that promote broader prairie conservation issues, including Burrowing Owl conservation needs, should be developed and distributed to land managers and schools. The Burrowing Owl can be used to encourage land stewardship that benefits other grassland wildlife.

Education Action Items

(1) Use the Burrowing Owl as a flagship species to promote broader prairie conservation issues. Education programs in the U.S., Canada, and Mexico could include teaching the value of native grasslands and their components (e.g., Burrowing Owls, prairie dogs, insects, grasses).

(2) Develop specific educational material for school curricula, such as Alberta's Burrowing Owl teachers' guide (Alberta Environmental Protection, 1995, Edmonton, Alberta, Canada).

(3) Promote the conservation of the Burrowing Owl and other grassland wildlife through newspapers, magazines, and other media.

Where possible, local people should be involved in Burrowing Owl research. Research results should be reported in local media.

(4) Develop prairie conservation literature specifically for landowners. Environment Canada, Rocky Mountain Bird Observatory, and others have produced landowner booklets that can be used immediately (Holroyd et al. 1995). Grassland habitat displays should be included in regional, agricultural, and nature interpretive centers.

(5) Use non-releasable Burrowing Owls and captive-bred, imprinted owls for educational programs where possible.

(6) Use the Internet to educate the public about Burrowing Owls, fossorial mammals, and grassland wildlife conservation (e.g., provide lesson plans, Burrowing Owl web pages, research results).

RESEARCH

Causes of the decline of the western Burrowing Owl are not fully known. Research is needed to determine causes so that management actions can be targeted and implemented to reverse the decline. In Canada, research has shown that productivity is low and mortality is high, but little is known about the extent of dispersal or emigration of owls into various parts of Canada and the U.S.

Research Action Items

(1) Study the population demographics of Burrowing Owls in the U.S. and Mexico to compare to existing Canadian data and to help determine causes of declines.

(2) Conduct population modeling that incorporates existing demographic data to determine gaps in our knowledge and possible causes of the decline.

(3) Determine annual site fidelity of migratory adult and juvenile owls. Accurate population modeling requires separation of emigration from annual mortality.

(4) Determine the effect of predation (from both natural and feral predators) and other sources of mortality on Burrowing Owl populations and establish how these factors contribute to population declines.

(5) Model Burrowing Owl habitat-use and habitat-selection, including human-related factors, to understand the role of human activity (i.e., agriculture, urbanization) in population declines.

(6) Conduct research on the distribution, survival, and threats to wintering owls.

(7) Determine routes, habitat needs, and survival of migrating owls, because little is known about this part of the annual cycle.

(8) Study the effects of pesticides on owls and their food in both summer and winter in all three countries.

(9) Evaluate the effects of grazing systems, fire, and other land uses on Burrowing Owls, their prey, and habitats.

(10) Conduct social science research to examine and to improve landowners attitudes toward burrowing mammals.

ADMINISTRATION

Official international agreements are needed to establish functional, cooperative programs between government agencies, universities, and research centers of the three countries included in the North American Free Trade Agreement. Common strategies of natural resource management and conservation should be developed and supported jointly by each national agency. In 1996, the federal wildlife agencies of the United States, Mexico, and Canada established the Canada/Mexico/U.S. Trilateral Committee for Wildlife and Ecosystem Conservation and Management (Trilateral). The Trilateral Committee facilitates and enhances cooperation and coordination among the countries' wildlife agencies in programs for the conservation and management of wildlife, plants, biological diversity, and ecosystems of mutual interest. In 1997, the Trilateral established a Burrowing Owl Working Group comprised of one representative per country to determine the conservation needs of this species. The Ogden Symposium and this paper were organized on this group's behalf. Some of the issues identified in this paper were included in the Commission for Environmental Cooperation's "Species of Common Conservation Concern in North America" (unpubl. draft 2000, Montreal).

Administrative Action Items

(1) Present the recommendations from the Burrowing Owl Symposium at the Trilateral Meeting. This was done at the 2000 Trilateral meeting in Padre Island, Texas, and updated at the 2001 meeting in Ottawa, Ontario.

(2) Promote greater international cooperation be-

tween the three countries to conserve Burrowing Owls. A North American Burrowing Owl Conservation Program should be initiated as a joint effort between the U.S., Canada, and Mexico.

(3) A list serve was established to enhance communication among Burrowing Owl conservationists. To subscribe send the following message to *listserv@unl.edu* with "subscribe burrowingowl *your name*" in the message and leave the subject line blank.

(4) Update the Burrowing Owl bibliography of Clark et al. (1997) that has been made available, with additions, on the web (http://uwadmnweb.uwyo.edu/fish_wild/buow/index.html).

(5) Strengthen links with other grassland researchers and scientific societies concerned with grassland habitat and its components. The resolution of the American Society of Mammalogists (1998) regarding conservation of prairie dogs and their habitat was endorsed by the Burrowing Owl Symposium attendees.

(6) Provide up-to-date information on Burrowing Owls to international bird conservation programs, such as Partners in Flight and the North American Bird Conservation Initiative, to support the conservation ranking of this species as high priority.

(7) Organize another symposium in 2001 in conjunction with the annual meeting of the Raptor Research Foundation, Inc., in New Orleans.

CONCLUSIONS

Burrowing Owls continue to undergo mild to severe local and regional population declines throughout much of their range in North America. Habitat destruction and alteration has played a major role in the decline of the Burrowing Owl. Increased mammalian predation, pesticide use, and other human-related mortality factors also may have contributed. Prairie dogs and ground squirrels continue to be exterminated in many areas of North America, and prairie grasslands continue to be converted for crop farming and other uses. Livestock production on grasslands often does not provide for conservation of native habitats and wildlife. Species such as Burrowing Owls and prairie dogs serve as important sentinels of the overall health of grassland ecosystems in North America, and currently they are telling us that our native grasslands are degraded in many areas. Proactive conservation measures, education, and changes in public attitudes and policy are necessary for the maintenance of viable populations of Burrowing Owls and grassland sciurids in North America. Integrated efforts to conserve native grassland habitats, and hence Burrowing Owls, should involve researchers, federal, state, and local governments, non-governmental organizations, and interested private citizens from all three North American countries.

ACKNOWLEDGMENTS

We thank J. Belthoff, D. Flath, R.K. Murphy, H. Trefry and T.I. Wellicome for interesting discussions on Burrowing Owls, and L. Ayers, J. Bednarz, J. Hoth, S.L. Jones, D.J. Krueper, J.L. Lincer, R. List, R. Mesta, D. Rosenberg, J. Sidle, K. Steenhof, D. Stepnisky, T.I. Wellicome, and H.E. Trefry for helpful comments on the manuscript Centro de Investigaciones Biológicas del Noroeste and CONACyT (México; 31372-N) supported the work of R Rodríguez-Estrella.

LITERATURE CITED

AMERICAN SOCIETY OF MAMMALOGISTS. 1998. Resolution on the decline of the prairie dogs and the grassland ecosystem in North America; 78th Annual Meeting of American Society of Mammalogists. *J. Mammal.* 29. 1447–1448.

BISHOP, N.G. AND J.L. CULBERTSON. 1976. Decline of prairie dog towns in southwestern North Dakota. *J. Range Manage.* 29:217–220.

CLARK, R.J., J.L. LINCER, AND J.S. CLARK. 1997. A bibliography on the Burrowing Owl (*Speotyto cunicularia*). Appendix A. Pages 145–170 *in* J.L. Lincer and K. Steenhof [EDS.], The Burrowing Owl, its biology and management including the proceedings of the first international Burrowing Owl symposium. J. Raptor Res. Report 9.

DE SMET, K.D. 1997. Burrowing Owl (*Speotyto cunicularia*) monitoring and management activities in Manitoba, 1987–1996. Pages 123–130 *in* J.R. Duncan, D.H. Johnson, and T.H. Nicholls [EDS.], Biology and conservation of owls of the northern hemisphere: 2nd international symposium. USDA Gen. Tech. Rep. NC-190, St. Paul, MN U.S.A.

DELEVORYAS, P. 1997. Relocation of Burrowing Owls during courtship period. Pages 138–144 *in* J.L. Lincer and K. Steenhof [EDS.], The Burrowing Owl, its biology and management including the proceedings of the first international Burrowing Owl symposium. J. Raptor Res. Report 9.

DIARIO OFICIAL DE LA FEDERACIÓN. 1994. Especies y subespecies de flora y fauna silvestres terrestres y acuáticas en peligro de extinción, amenazadas, raras y las sujetas a protección especial. Norma Oficial Mexicana. Tomo CDLXXXVIII, No. 10. México, D.F.

ENRIQUEZ-ROCHA, P. 1997. Seasonal records of the Bur-

rowing Owl in Mexico. Pages 49–51 *in* J.L. Lincer and K. Steenhof [EDS.], The Burrowing Owl, its biology and management including the proceedings of the first international Burrowing Owl symposium. J. Raptor Res. Report 9.

———, J.L. RANGEL-SALAZAR, AND D.W. HOLT. 1993. Presence and distribution of Mexican owls: a review. *J. Raptor Res.* 27:154–160.

FEENEY, L.R. 1997. Burrowing Owl site tenacity associated with relocation efforts. Pages 132–137 *in* J.L. Lincer and K. Steenhof [EDS.], The Burrowing Owl, its biology and management including the proceedings of the first international Burrowing Owl symposium. J. Raptor Res. Report 9.

HAUG, E.A. AND A.B. DIDIUK. 1991. The status of the Burrowing Owl in Canada: an update report. Committee on the Status of Endangered Wildlife in Canada, Can. Wildl. Serv., Ottawa, ON Canada.

———, B.A. MILLSAP, AND M.S. MARTELL. 1993. Burrowing Owl (*Speotyto cunicularia*). *In* A. Poole and F. Gill [EDS.], The birds of North America, No. 61. The Academy of Natural Sciences, Philadelphia, PA and American Ornithologists' Union, Washington, DC U.S.A.

HJERTAAS, D., S. BRECHTEL, K. DE SMET, O. DYER, E. HAUG, G.L. HOLROYD, P. JAMES, AND J.K. SCHMUTZ. 1995. National Recovery Plan for the Burrowing Owl. Recovery of Nationally Endangered Wildlife (RENEW) Report No. 13. Can. Wildl. Serv. Ottawa, ON Canada.

HOLROYD, G.L., I. SHUKSTER, D. KEITH, AND L. HUNT. 1995. A landowner's guide to prairie raptors. Canadian Wildlife Service, Environment Canada, Edmonton, AB Canada. (ISBN#0-662-23038-8).

JAMES, P.C. AND R.H.M. ESPIE. 1997. Current status of the Burrowing Owl in North America: an agency survey. Pages 3–5 *in* J.L. Lincer and K. Steenhof [EDS.], The Burrowing Owl, its biology and management including the proceedings of the first international Burrowing Owl symposium. J. Raptor Res. Report 9.

LEUPIN, E.E. AND D. LOW. 2001. Burrowing Owl reintroduction efforts in the Thompson/Nicola region of British Columbia. *J. Raptor Res.* 35:392–398.

LINCER, J.L. 1997. Toward an action plan: the results of the Burrowing Owl workshop, November 14, 1992, Bellevue, Washington. Pages 11–13 *in* J.L. Lincer and K. Steenhof [EDS.], The Burrowing Owl, its biology and management including the proceedings of the first international Burrowing Owl symposium. J. Raptor Res. Report 9.

——— AND K. STEENHOF. 1997. The Burrowing Owl, its biology and management including the proceedings of the first international Burrowing Owl symposium. J. Raptor Res. Report 9.

MARTELL, M.S., J. SCHLADWEILER, AND F. CUTHBERT. 2001. Status and attempted reintroduction of Burrowing Owls in Minnesota, U.S.A. *J. Raptor Res.* 35:331–336.

MILLER, B., G. CEBALLOS, AND R. READING. 1994. The prairie dog and biotic diversity. *Conserv. Biol.* 8:677–681.

PALACIOS, E., D.W. ANDERSON, E. MELLINK, AND S. GONZALEZ-GUZMAN. 2000. Distribution and abundance of Burrowing Owls on the peninsula and islands of Baja California. *West. Birds* 31:89–99.

POULIN, R.G. 1999. Burrowing Owl nest box: Construction and installation procedures. Saskatchewan Environment and Resource Management, Fish and Wildlife Branch, Regina, SK. 9 pp.

RODRÍGUEZ-ESTRELLA, R. 1997. Nesting sites and feeding habits of the Burrowing Owl in the biosphere reserve of Mapimi, Mexico. Pages 99–106 *in* J.L. Lincer and K. Steenhof [EDS.], The Burrowing Owl, its biology and management including the proceedings of the first international Burrowing Owl symposium. J. Raptor Res. Report 9.

———, J.A. DONÁZAR, AND F. HIRALDO. 1998. Raptors as indicators of environmental change in the scrub habitat of Baja California Sur, Mexico. *Conserv. Biol.* 12 921–925.

RZEDOWSKI, J. 1978. Vegetación de México. Editorial Limusa, México, D.F.

SAMSON, F.B. AND F.L. KNOPF. 1996. Prairie conservation, preserving North America's most endangered ecosystem. Island Press, Washington, DC U.S.A.

SAUER, J.R., J.K. HINES, I. THOMAS, J. FALLON, AND G GOUGH. 2000. The North American breeding bird survey results and analysis. Version 98.1. Patuxent Wildlife Research Center, Laurel, MD U.S.A. http://www.mbr-pwrc.usgs.gov./bbs/.

SCHULTZ, T.A. 1997. Observations, resightings, and encounters of rehabilitated, orphaned, and relocated Burrowing Owls. Pages 128–131 *in* J.L. Lincer and K Steenhof [EDS.], The Burrowing Owl, its biology and management including the proceedings of the first international Burrowing Owl symposium. J. Raptor Res. Report 9.

SCOBIE, D. AND FAMINOW. 2000. Development of standardized guidelines for petroleum industry activities that affect COSEWIC prairie and northern region vertebrate species at risk. Avocet Environmental Inc., Ghostpine Environmental Services Ltd., and Environment Canada, Edmonton, AB Canada.

SHEFFIELD, S.R. 1997a. Current status, distribution, and conservation of the Burrowing Owl in midwestern and western North America. Pages 399–408 *in* J.R. Duncan, D.H. Johnson, and T.H. Nicholls [EDS.], Biology and conservation of owls of the northern hemisphere: 2nd international symposium. USDA Gen Tech. Rep. NC-190, St. Paul, MN U.S.A.

———. 1997b. Owls as biomonitors of environmental health hazards. Pages 383–398 *in* J.R. Duncan, D.H Johnson, and T.H. Nicholls [EDS.], Biology and conservation of owls of the northern hemisphere: 2nd international symposium. USDA Gen. Tech. Rep. NC-190, St. Paul, MN U.S.A.

——— AND M. HOWERY. 2001. Current status, distribution, and conservation of the Burrowing Owl in Oklahoma. *J. Raptor Res.* 35:351–356.

SKEEL, M.A., J. KEITH, AND C.S. PALASCHUK. 2001. A population decline recorded by Operation Burrowing Owl in Saskatchewan. *J. Raptor Res.* 35:371–377.

TATE, J., JR. 1986. The blue list for 1986. *Am. Birds* 40: 227–236.

U.S. DEPARTMENT OF INTERIOR. 1991. Endangered and threatened wildlife and plants; animal candidate review for listing, proposed rule: Part VIII. *Federal Register* 56:58804–58836.

U.S. DEPARTMENT OF INTERIOR. 1992. Endangered and threatened wildlife and plants. 50 CFR 17.11 and 17.12, 29 August 1992.

U.S. FISH AND WILDLIFE SERVICE. 2001. Birds of Conservation Concern 2001. U.S. Fish and Wildl. Serv., Div. Migratory Bird Manage., Arlington, VA U.S.A.

VERCAUTEREN, T.L., S.W. GILLIHAN, AND S.W. HUTCHINGS. 2001. Distribution of Burrowing Owls on public and private lands in Colorado. *J. Raptor Res.* 35:357–361.

WEDGWOOD, J.A. 1978. The status of the Burrowing Owl in Canada. Committee on the Status of Endangered Wildlife in Canada, Can. Wildl. Serv., Ottawa, ON Canada.

WELLICOME, T.I. 2000. Effects of food on reproduction in Burrowing Owls (*Athene cunicularia*) during three stages of the breeding season. Ph.D. dissertation, Univ Alberta, Edmonton, AB Canada.

——— AND E.A. HAUG. 1995. Second update of status report on the Burrowing Owl *Speotyto cunicularia* Committee on the Status of Endangered Wildlife in Canada, Can. Wildl. Serv., Ottawa, ON Canada.

——— AND G.L. HOLROYD. 2001. The second international Burrowing Owl symposium: background and context. *J. Raptor Res.* 35:269–273.

WHITE, C.M. 1994. Population trends and current status of selected western raptors. *Stud. Avian Biol.* 15:161–172.

WORLD WILDLIFE FUND CANADA. 1988. Prairie conservation action plan. WWFC, Toronto, ON Canada.